**We Claim:**

1. A cardiac pacing system having a pacemaker and lead means for interconnecting the pacemaker and the patient's heart, the pacemaker having pulse means for generating pacing pulses and control means for controlling the operation of the pacemaker, the lead means having electrode means for delivering pacing pulses to a patient's heart and for acquiring cardiac signals, the pacemaker having DSP means for amplifying and processing the cardiac signals acquired by the electrode means, and means for classifying the acquired cardiac signals, the DSP means comprising at least one DSP channel, the pacing system comprising:

conversion means for converting the acquired and amplified signals to digital signals;

digital filter means for filtering the converted signals to provide filtered signals;

slope means for operating on the filtered signals to provide slope signals representative of the slope of the filtered signals;

sense means for determining from the filtered signals and the slope signals whenever a cardiac event is detected, and the sense time of each ~~the~~ detection;

analysis window means for timing out an analysis window of predetermined duration following the sense time;

parameter means for processing the filtered signals and the slope signals during the analysis window, and for generating a plurality of respective parameters from the signals;

classification means for receiving the parameters from the DSP means and for classifying each signal as a function of the parameters, and

monitoring means for determining and detecting whether each classified signal corresponds to a predetermined heart condition.

2. The system described in claim 1, wherein the pacemaker comprises a computing device selected form the group consisting of a Digital Signal Processor ("DSP"), a microprocessor, an Application Specific Integrated Circuits ("ASIC"), a controller, a micro-controller, a mini-controller, a computer, a micro-computer, and a Central Processing Unit (CPU), and the classification means comprises the computing device and an algorithm for operating upon the parameters.

3. The system described in claim 2, wherein the electrode means comprises means for acquiring a plurality of respective intracardiac signals, and wherein the DSP means comprises a plurality of the channels, each channel corresponding to a respective one of the intracardiac signals, and wherein the classification means comprises a plurality of respective programmable algorithms for processing the parameters generated by each the channel.

4. The system described in claim 1, wherein the conversion means comprises a delta-sigma modulator circuit, and wherein DSP means further comprises interconnection means for interconnecting the conversion means, the digital filter means, the slope means, the sense means and the parameter means.

5. The system described in claim 1, wherein the parameter means comprises means for deriving four parameters from the filtered signal during each the analysis window and for deriving four respective parameters from the slope signal during each the analysis window, and wherein the classification means comprises means for classifying each acquired signal as a function of the four signal parameters and the four slope parameters.

6. The system described in claim 5, wherein the parameter means further comprises means for deriving a signal length as a function of comparing the filtered signals and the slope signals to predetermined threshold criteria.

7. The system described in claim 1, wherein the sense means comprises means for comparing the filtered signals with at least one predetermined threshold and for comparing the slope signals with at least another predetermined threshold.

8. The system described in claim 7, wherein the sense means comprises means for determining when the magnitude of the filtered signals has exceeded the one predetermined threshold and the magnitude of the slope signals has exceed the another threshold within a predetermined time interval.

9. The system described in claim 1, wherein the parameter means comprises means operative during the analysis window for determining a minimum and maximum value for the filtered signals and for the slope signals.

10. The system described in claim 9, wherein the electrode means comprises means for acquiring atrial signals, and the classifying means comprises means for distinguishing at least one of P waves, R waves and FFRWs as a function of the minimum and maximum values for the filtered signals.

11. The system described in claim 10, wherein the classifying means comprises means for distinguishing P waves and FFRW waves as a function of the sum of the slope maximum and minimum absolute values during the analysis window.

12. The system described in claim 10, wherein the classifying means comprises stored criteria relating to retrograde P waves, and comprises a software algorithm for distinguishing retrograde P waves from natural sinus P waves by comparing the minimum and maximum values to the criteria.

13. The system described in claim 10, wherein the classifying means comprises means for distinguishing at least two of FFRWs, intrinsic P waves, evoked response P waves, retrograde P waves, PACs, sinus P waves, evoked response R waves, and R waves from one another.

14. The system described in claim 9, wherein the electrode means comprises means for acquiring ventricular signals, and wherein the classifying means comprises means for classifying PVCs.

15. The system described in claim 1, further comprising means for triggering a predetermined response by the pacemaker system in response to detection of the predetermined heart condition.

16. The system described in claim 15, wherein the means for triggering a predetermined response is operably connected to a means for delivering the predetermined response.

17. The system as described in claim 16, wherein the means for delivering the predetermined response is selected from the group consisting of an intracardiac drug therapy localized delivery apparatus, at least one intracardiac pacing electrode, at least one intracardiac defibrillation electrode, and an intracardiac gene therapy localized delivery apparatus.

18. The system described in claim 1, wherein the predetermined heart condition is ischemia or cardiomyopathy and the monitoring and detecting means further comprises means for distinguishing between FFRWs or R waves corresponding to an ischemic or cardiomyopathic condition of the patient's heart and FFRWs or R waves corresponding to a non-ischemic or non-cardiomyopathic condition of the patient's heart.

19. The system as described in claim 1, wherein the monitoring and detecting means further comprises means for differentiating between classified signals on the basis of wave parameters.

20. The system as described in claim 19, wherein the wave parameter employed by the differentiating means is selected from the group consisting of positive signal slope, negative signal slope, positive signal amplitude, negative signal amplitude, delay times corresponding to maximum values of signals, delay times corresponding to minimum values of signals, and any combination of the foregoing.

21. A method of detecting a heart condition in a patient's heart using a cardiac pacing system, the cardiac pacing system having a pacemaker and lead means for inter-connecting the pacemaker and the patient's heart, the pacemaker having pulse means for generating pacing pulses and control means for controlling the operation of the pacemaker, the lead means having electrode means for delivering pacing pulses to a patient's heart and for acquiring cardiac signals, the pacemaker having DSP means for amplifying and processing the cardiac signals acquired by the electrode means, and classifying means for classifying acquired cardiac signals, the DSP means comprising at least one DSP channel, the pacing system comprising conversion means for converting the acquired and amplified signals to digital signals, digital filter means for filtering the converted signals to provide filtered signals, slope means for operating on the filtered signals to provide slope signals representative of the slope of the filtered signals, sense means for determining from the filtered signals and the slope signals whenever a cardiac event is detected, and the sense time of each the detection, analysis window means for timing out an analysis window of predetermined duration following the sense time, parameter means for processing the filtered signals and the slope signals during the analysis window, and for generating a plurality of respective parameters from the signals, classification means for receiving the

parameters from the DSP means and for classifying each signal as a function of the parameters, and monitoring means for determining whether each classified signal corresponds to a predetermined heart condition, the method comprising:

(a) acquiring an intracardiac signal;

(b) amplifying the acquired intracardiac signal;

(c) filtering the amplified intracardiac signal to provide a filtered signal;

(d) operating on the filtered signal to a provide a slope signal;

(e) determining from the filtered signal and slope signal when a cardiac event has been detected;

(f) processing the filtered signal and the slope signal during an analysis window triggered by the detection of a cardiac event;

(g) generating wave parameters corresponding to each of the filtered signal and the slope signal;

(h) classifying each signal as a function of the wave parameters;

(i) determining and detecting on the basis of the wave parameters whether each classified signal corresponds to a predetermined heart condition.

22. The method of claim 21, further comprising triggering a predetermined response by the pacemaker system when the predetermined heart condition is detected.

23. The method of claim 22, wherein the predetermined response is selected from the group consisting of delivering a drug, delivering a gene therapy, delivering a pacing therapy, delivering a defibrillation therapy, delivering a cardioversion therapy, and delivering an anti-tachycardia pacing therapy.

24. The method of claim 21, wherein the predetermined heart condition is ischemia or cardiomyopathy and the monitoring and detecting means further



71

distinguishes between FFRWs, R waves or evoked response R waves corresponding to an ischemic or cardiomyopathic condition of the patient's heart and FFRWs, R waves or evoked response R waves corresponding to a non-ischemic or non-cardiomyopathic condition of the patient's heart.

25. The method of claim 21, further comprising acquiring and classifying at least one intracardiac control signal corresponding to a healthy cardiac condition of the patient.

26. The method of claim 25, further comprising storing in a memory of the system at least one control wave parameter corresponding to the at least one control signal.

27. The method of claim 26, further comprising comparing the at least one control wave parameter to a wave parameter corresponding to an acquired signal.

28. The method of claim 27, further comprising determining, on the basis of the comparison between the control signal wave parameter and the acquired signal wave parameter, whether the predetermined heart condition exists.

29. The method of claim 21, further comprising differentiating between classified signals on the basis of wave parameters.

30. The method of claim 29, wherein the wave parameter employed in differentiating is selected from the group consisting of positive signal slope, negative signal slope, positive signal amplitude, negative signal amplitude, delay times corresponding to maximum values of signals, delay times corresponding to minimum values of signals, signal width, and any combination of the foregoing.



97

31. The method of claim 21, further comprising storing in a memory of the system a plurality of wave parameters corresponding to a plurality of sensed cardiac events.

32. The method of claim 21, further comprising detecting changes in the characteristics of the plurality of stored wave parameters as new wave parameters are stored in the memory.

33. The method of claim 21, wherein only one wave parameter is employed to detect the predetermined heart condition.

34. The method of claim 21, wherein both wave parameters are employed to detect the predetermined heart condition.